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ABSTRACT

This document is intended to help Australian technical and further education instructors in New South Wales (TAFE NSW) identify teaching principles and learning activities that they can use to help adult learners master the mathematics processes, knowledge, and skills needed to perform basic measurement tasks in today's workplace. The materials are specifically designed to support delivery of the TAFE NSW module Measurement for Work, one of the modules leading to a Certificate in Local Government Foundation Studies. Part 1 is a teaching guide that presents specific classroom techniques for helping learners understand and/or use the following: problem solving; estimation; mathematical reasoning; geometry; measurement (perimeter, area, volume, temperature, time); number (whole numbers, decimals, percentages, ratios, rates, fractions); and graphs, tables, and charts. Part 2 contains ideas for work-based projects integrating on-the-job and training activities to develop learner's measurement skills. The activities and sample worksheets provided are designed to provide practice in typical workplace tasks performed in three workplaces: a water treatment facility; public construction projects; and horticulture and landscaping in parks and gardens. Appended are the following: metric conversion factors; metric prefixes; relationship between mass, capacity, and volume; and chemical dosing calculation chart. (MN)

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MEASUREMENT for WORK

Teaching Gu
Sample Learning A

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MEASUREMENT for WORK

Teaching guide and sample learning activities

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Margo Angel and Chris Bolton

Foundation Studies Training Division
Western Sydney Institute of TAFE

Measurement for Work: Teaching Guide and Sample Learning Activities

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Introduction

This resource was developed to support the TAFE NSW module Measurement for Work, located in the Certificate in Local Government Foundation Studies.

This material is also relevant for teachers and students in many workplace settings in which maths demands require focussed strategies.

In the syllabus of Measurement for Work (p. 2), the module purpose is stated as follows:

> This module is designed to assist learners with the development of measurement skills and knowledge required for work and training.
>
> After completing the module, learners will be able to recognise and use metric measurement, use a calculator for problem solving, solve simple equations, complete conversions between units of measurement and calculate area and volume.'

The teaching guide

As the name implies, this is only a guide to the knowledge, skills and processes which may be addressed. Because of the multitude of numeracy demands in the workplace and the certificate modules, it would be impossible to cover all examples. Therefore, the responsibility of integrating theory and practice into suitable work-based activities lies with the module teacher.

All content and activities should be negotiated, planned and integrated into practical, work-based examples which address the learning outcomes of the module. Activities and assessments may be negotiated to range from those with a single focus, to more complex, work-based projects.

The teaching guide has been set out in a way which will assist you to identify some of the processes, knowledge and skills which can form a basis for *your* interpretation and development of the module Measurement for Work. Because many of the learning outcomes will be addressed concurrently, the guide is structured around suggested areas of mathematical processes, knowledge and skills.

The sample learning activities

This guide has been set out to model options for development in three areas:

- projects developed to address specific workplace demands
- activities developed to complete current workplace tasks
- samples of work developed to support vocational curriculum modules.

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All activities included reflect the emphasis on integrating relevant work-based theory and practical numeracy skills. This should also be evident in all assessment tasks.

In developing this document, the writers acknowledge that they do not have comprehensive experience in all areas which may require numeracy support. Therefore, this guide has been developed as a 'living document'. It is recommended that you add any information, task assessments and so on which you develop.

The time spent addressing different areas of learning outcomes will depend on the needs of the particular learners.

Target group

This module has been flexibly designed to allow for adaptation to current workplace requirements and to the numeracy needs of participants at all levels of the three certificates. It is important to realise that your group may be made up of participants with varying skill levels and learning needs, who are probably from different council departments. Consequently, the content should be tailored to meet the workplace and module requirements of each participant.

Notes for teachers and trainers

Many of the stages of mathematical development require literacy skills: listening, speaking, reading, writing and critical thinking. The same approach used in the teaching of literacy and language will be necessary in the teaching of numeracy. Discussions in group learning situations, collaboration between teacher and student, and collaboration between student and student are all important.

Activities in this module may involve the use of a calculator. Remember that some participants may not have used calculators before

Teaching principles

- To explain ideas, concepts and terminology, teachers should use language that can be understood by the participants, and be applied in talking, reading, writing, listening and critical thinking.
- Participants learn through interaction and co-operation which involves talking, questioning, explaining and working co-operatively.
- Content should revolve around practical activities and hands-on materials.
- Both on- and off-the-job teaching and learning experiences should be included.
- Develop the confidence of participants.
- The National Framework of Adult English Language, Literacy and Numeracy Competencies should be used as a reference.

PART 1: Teaching guide

Processes

Interweave the following processes through the module.

1. Problem solving

Steps:

1. Read the information
2. Think about the parts and process
3. Estimate
4. Calculate
5. Compare estimation and calculation
6. Re-calculate if necessary

Strategies:

- Use meaningful tasks that are needs-based/work-based. Plan and prepare activities so that learners develop a range of skills and strategies.
- Encourage learners to draw on their personal store of mathematical experiences to solve problems.
- Where possible, use co-operative problem-solving in pairs or small groups.
- Encourage and support learners to feel confident in their ability to solve problems and provide creative solutions.

2. Estimation

This involves rounding and approximating, estimating using size concepts and mathematical commonsense, and being alert to reasonableness of results.

- Investigate reasons for estimation.
- Language of estimation: roughly, around, about, approximately, nearest.
- Practice estimating lengths, heights, areas, and so on, of things which can be checked.
- Compare capacity of relevant containers, such as medicine cup, measuring spoon, teaspoon, truck, tanker, tank and so on.
- Estimate speeds, distances, and so on, relevant for site and traffic control.

3. Mathematical reasoning

Verbalising methods and difficulties.

As reasoning requires interaction, discussion, asking questions, giving explanations and testing results, opportunities for discussion (using everyday language) must be provided.

- Learners must discuss what they know, what they need to find out, how to go about it and how they achieve the result.
- Provide opportunities for describing the reasoning used to obtain results (success or failure).
- It is important to link new concepts to known structures or previous knowledge.
- Apply concepts to work-based activities.

Knowledge and skills

The following areas of knowledge and skills are to be integrated into the projects and activities undertaken to address the learning outcomes.

Geometry

- Ask learners to identify and describe two- and three-dimensional shapes with workplace significance. This may be carried out as a brainstorm session.
- Record known two- and three-dimensional shapes evident in the workplaces of participants on the whiteboard.

circle	oval	ellipse
square	rectangle	triangle
cube	conical	rectangular prism
cylinder	pipes	sphere

- Recognise and use appropriate terms to describe these shapes. Language:

length	height	perimeter	radius
breadth	diagonal	equal	centre
width	side	circumference	arc
depth	parallel	diameter	sector
angle	right angle		

This language should be related to models, diagrams and work-based samples.

Measurement

- It is important to emphasise practical experiences and estimation. Collect and record workplace samples.
- Learners should be able to recognise and name units of metric measurement. To find out what they know about measurement, you could brainstorm all known units of measurement. This may be done on small groups, or as a class group. Participants may volunteer both metric and imperial units of measurement, such as:

kilogram	inch	hundredweight	chain
metre	feet	pound	kilometre
kilojoule	yard	ounce	gram
tonne	ton	stone	kilolitre
litre	gram	milligram	millimetre
centimetre	millilitre	megalitre	cubic metre
year	micron	cubic yard	degree Fahrenheit
hour	minute	second	degree Celcius
week	day	month	

- By recording all units on the whiteboard, special groupings may then be identified, for example:

  metric / imperial
  length / mass / capacity / time

- Learners need to be able to identify base units of measurement:

length:	mm	m	km
mass:	mg	g	kg
capacity:	mL	L	kL
time:	sec.	min.	hr

- In order to select and use appropriate measuring equipment, learners could be asked to list measuring equipment in their workplace.

  length: rulers, measuring tapes (5 m, 10 m), vernier callipers, trundle wheel

  mass: kitchen scales, bathroom scales, hook scales, digital scales

  capacity: medicine cup, measuring cups, measuring spoons, jugs, milk cartons (500 mL, 1 L, 2 L)

  time: analog, digital

  other: thermometer, odometer, gas meter, water meter, clock, watch (digital, analog), counter, speedometer, calendar

- Participants should then be given opportunities to use the various types of measuring equipment identified. This may be carried out by:
  - setting up a variety of work-stations/measuring projects where work and / or curriculum-based measuring activities are completed
  - carrying out on-the-job measurement tasks; this option may prove limiting to the variety of measuring tasks which can be experienced at a particular time
- Provide opportunities to develop an idea of the 'sizes' of relevant units of measure in order to be able to accurately estimate. Because adults learn best when content is personally relevant, learning content should be derived from learner's needs. Concepts may be difficult to grasp unless linked to useful tasks.
- A wide variety of tasks should be undertaken to allow for consolidation.
- To assist with the understanding of the metric system, it may be helpful to link metric prefixes to numerical values.

milli:	$\frac{1}{1000}$
centi:	100
kilo:	1000

- This information may then be linked to the identification and use of metric symbols: mm, cm, m, km, mL, L, and so on.
- Many measurement calculations require conversion between units of metric measurement. Be aware that many people who are not familiar with the metric system of measurement become very anxious when they hear words like millimetre and kilometre. Some suggestions:

  Discuss the base ten notion of the metric system.

  Establish metric facts:

1000 mm = 1 m	1000 g = 1 kg	1000 mL = 1 L[1]
1000 m = 1 km	1000 kg = 1 t	1000 L = 1 kL

  Introduce the concept of 're-naming' units of measurement (maybe linking with dollars and cents).

[1] The upper case L is used to denote litres. This is the preferred option in order to avoid confusing the lower case l for the numeral 1.

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Provide opportunities to develop the skill of making quick conversions, for example:

$\frac{1}{2}$ m = 500 mm $\frac{1}{4}$ L = 250 mL 3000 g = 3 kg

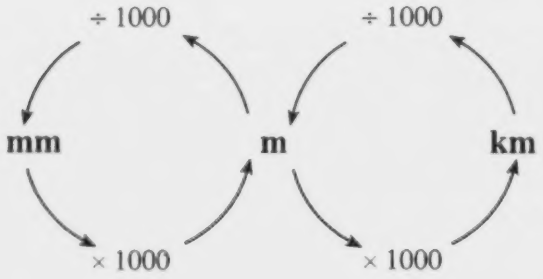
800 m = 0·8 km 3750 mL = 3·75 L

If work on decimals is required, it is suggested that this work be addressed concurrently.

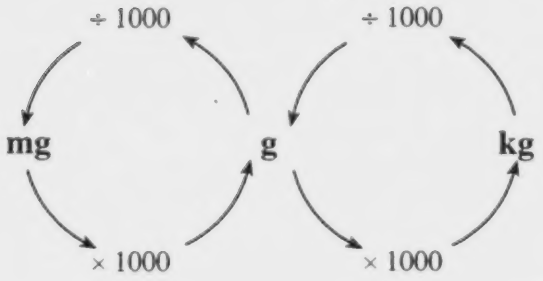
Check that the learners feel confident using the calculator to complete work tasks.

The following conversion diagrams have been found useful by students:

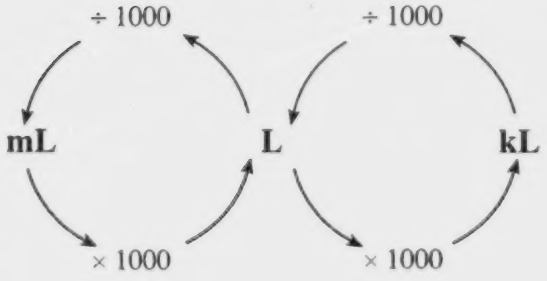
length:



mass:



capacity:



In addressing perimeter, area and volume it is important to emphasise practical work-based experiences, and the use of estimation. Work-based tasks may include calculations relating to pools, tanks, trucks, sand, soil, concrete, mulch, and so on.

Perimeter

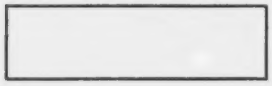
- Learners should discuss and complete workplace or curriculum examples of perimeter, for example fencing, roping-off areas, garden edging.

Area

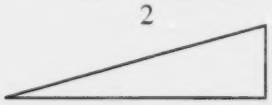
- Participants should describe and calculate workplace or curriculum examples of area. Examples should reflect specific tasks of the departments represented.

  a) Areas of regular shapes

$A = L \times B$

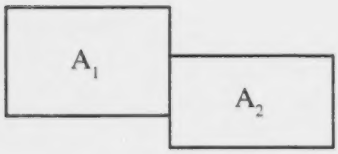


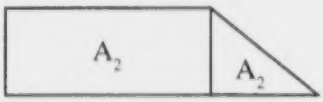
$A = \frac{1}{2} L \times B$



These calculations may be required for painting, paving, top dressing, fertilising, and so on.

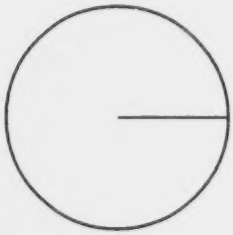
b) Areas of compound shapes





$A = A_1 + A_2$

c) Areas of circles



$A = \pi r^2$

Volume

- Participants should describe and calculate workplace or curriculum examples of area. Examples should reflect specific tasks of the departments represented.
- Workplace experiences should be used to develop concepts such as cubic metres. For example, trucks are likely to have capacities of 3 m^3, 5 m^3, or 10 m^3.

- It may be relevant to investigate the volume of everyday containers, for example, one-litre milk cartons, two-litre cartons, measuring cup, teaspoon, and so on.
- If necessary, link volume to capacity and mass, for example:

volume		capacity		mass
1 cm^3	=	1 mL	=	1 g (water at sea level)
1000 cm^3	=	1 L	=	1 kg

  This may be integrated with work, using metric conversion charts and tables.
- Encourage participants to use estimation and rounding skills. This may relate to activities such as ordering sand, soil, mulch, concrete, volumes of water, and so on.

Temperature

- Give participants the opportunity to develop an idea of various temperatures as they relate to their work tasks. For example, child care workers may need to know about normal body temperature, high body temperature, excessive body temperature; pool attendants may be required to regulate water temperatures related to solar heating, and so on; weed sprayers need to be aware of maximum and minimum temperatures above and below which spraying is not recommended.

Time

- Participants may require an understanding of:

  12-hour time

  24-hour time

  digital/analog time

  am, pm

These skills may be required for records on time sheets, MMS (Maintenance Management System) forms, daily record sheets, job sheets, and so on.

Number

Whole number

- Learners need to have calculator skills that will allow them to complete the four operations.
- Learners should be encouraged to estimate before all calculations.

- It would be useful for participants to understand the short-cut methods of multiplying by 10, 100 and 1000.
- Learners must have an understanding of squared numbers, square roots and cubic numbers. This should be integrated into working with metric measurement.
- Learners must be able to recognise and make records using appropriate mathematical symbols, for example r^2, m^3, ÷.
- Participants should investigate rounding. This may be carried out to the nearest whole, ten, tenth, or as required in the participant's particular work situation. This could be related to measuring to the nearest millimetre, ordering to the nearest 0.1 cubic metre, mixing sprays to the nearest 0.5 litre, and so on.
- Participants must be able to record numbers accurately. This skill will be required in many tasks, wherever numerical records are required.
- It may be beneficial for learners to discuss the various forms of recording mathematical computations, for example: $\frac{12}{3} = 12 \div 3 = 3\overline{)12} = 3\overline{)12}$

Decimals

- Participants require an understanding of decimal notation to three decimal places. Measuring and calculating to three decimal places gives workplace calculations a high degree of accuracy.
- It may be relevant to link decimals to known language to assist in developing awareness of 'sizes', for example:

  0·1 very small

  0·25 a quarter

  0·5 a half

  0·99 almost all
- This should lead on to developing an understanding of the difference between notations such as 3·0, 0·3, and 0·003.
- Participants should also be given the opportunity to consider equivalences, for example 0·3 = 0·30.
- Work with decimals should be referred and related to estimation. The above skills would assist with the 'appropriateness' of an estimation.
- Learners will be required to complete calculations with decimals, using the four operations.
- Calculator skills are recommended.

- Discuss 'short-cut' methods of multiplying and dividing decimals by 10, 100 and 1000.
- Some calculations may require rounding-off decimals to a required degree of accuracy.
- Where do we *see* decimals? Ideas can be shared in the group by brainstorming.

  money

  packaging/containers, for example 1·25 litres

  time sheets

  rates of pay

  overtime

  petrol price, for example cents/litre

  trip meters

  lengths of timber (standard lengths come in multiples of 0·3 of a metre)

  metric measurements

  digital time (9:20 am)
- Where do we *use* decimals at work? Ideas can be collated by the group through a brainstorming session.

Note: Council employees who work in road maintenance and construction may be familiar with the *RTA Field Handbook* which deals with the newly introduced Maintenance Management System (MMS). This system requires employees use the metric system for various measurement tasks, and to use decimal notation in the units of measure recorded.

Percentages

- Learners need to understand the meaning of the notation, and have a concept of 'size'. This can be assisted by linking percentage amounts to words and phrases, for example: 80% = a lot, 1% = not much.
- Participants should always be encouraged to estimate before they calculate.
- Participants must be able to find percentages of a given quantity, for example 10 per cent of 160 wires; allow a 5 per cent margin, and so on. Encourage the use of easy methods, for example:

  to find 10%: ÷ by 10

  to find 20%: ÷ by 10 then × by 2

  to find 30%: ÷ by 10 then × by 3

  to find 5%: ÷ by 10 then ÷ by 2

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Learners should have an understanding of the equivalence of common fractions, decimals and percentages, for example

$\frac{1}{2} = 0{\cdot}5 = 50\%$

$\frac{1}{4} = 0{\cdot}25 = 25\%$

$\frac{3}{4} = 0{\cdot}75 = 75\%$

$\frac{1}{10} = 0{\cdot}10 = 10\%$

Ratios

- Learners must develop the understanding that ratios compare quantities of the same kind.
- Learners should understand the equivalence of ratios, for example 2:10 = 1:5
- Learners should be made aware that the order in which ratios are written is important. For example, when mixing sprays, the ratio may be 1:20, meaning one part spray to twenty parts water.

Rates

- Learners may be required to understand comparisons of two different quantities, for example:

  km / hr

  $ / hr

  m / sec.

  heartbeats / min.

  words / min.

  L / hr

Fractions

- Learners require an understanding of the notation. A fraction is a numerical representation of a part or parts.

- Provide opportunities to learn about the equivalence of fractions, for example:

$$\frac{1}{2} = 0{\cdot}5 = \frac{5}{10}$$

- Learners should be able to write fractions as decimals, for example:

$$\frac{1}{10} = 0{\cdot}1 \qquad \frac{1}{4} = 0{\cdot}25$$

$$\frac{1}{2} = 0{\cdot}5 \qquad \frac{3}{4} = 0{\cdot}75$$

- Give participants the opportunity to find fractions of given quantities as they may apply in their workplace.

Graphs, tables and charts

- Where required, provide learners with experiences in gaining meaning from information presented in graphs, tables and charts.
- It is important to collect samples which are relevant to the work experiences or vocational module demands of individual participants.
- It may be necessary to review examples from the following:

  line graphs

  bar graphs, vertical and/or horizontal

  pie graphs

  conversion charts, for example imperial to metric.

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PART 2: Sample learning activities

Introduction

This section includes ideas for work-based projects integrating on-the-job and training activities to develop measurement skills.

Many of the work areas in local government require measurement skills. The demands of each job area vary, and examples of measurement tasks must be typical of the work activities of the learners. We have taken examples of workplace tasks from the areas of water treatment and supply, and horticulture. We have also included typical work tasks undertaken by outdoor staff, for which they must have a dogging skills licence (or, if completed prior to 1995, a crane chaser's licence).

This is a developing document in a new field of experience for adult basic education teachers. Examples and ideas are not available from all local government workplace areas. This resource is to give you some models and ideas that you can use to prepare activities based on the actual workplace of your group. We hope that the booklet will grow with examples developed within your sections, and from the TAFE adult basic education network which, over the years, has provided us with many of our best ideas.

Determine the content of both the learning and assessment activities according to the needs of the group and workplace demands. It may be necessary to develop calculator skills in conjunction with the measurement activities.

Different workplaces will demand specific measurement skills. For example, water treatment workers must have a thorough understanding of the relationship between mass and capacity in units from micrograms to tonnes and millilitres to megalitres.

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Measurement for water treatment and supply

Maths for capacity and checking meter accuracy

This activity grew out of the demands of the workplace:

- Sometimes meters measuring flow rates to record output must be adjusted for accuracy. The workers need to be able to run checks against the rise and fall of the water level in the tanks.
- The workers need to be able to estimate how long it will take for water to travel certain distances in pipelines when they are carrying out repairs and maintenance, to prevent wastage of clean water.

To carry out these tasks, workers require the following skills:

- calculator skills
- metric measurement
- area and capacity
- decimal fractions in measurement
- problem solving skills.

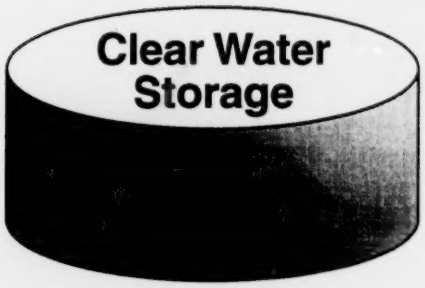
Assess the general mathematical skills of course participants, as some may have to develop the concepts, language and symbols of the four basic operations, as well as the above skills.

The origin of this outline is a Workplace English Language and Literacy (WELL) program funded by the Commonwealth Department of Employment Education and Training. TAFE NSW delivered this program during 1995 at Southern Riverina Electricity and Water, Wagga Wagga. It included, in connection with measurement, both on-site and on-the-job activities for seven two-hour sessions and one six-hour implementation morning.

In the first session we investigated metric measurement in the units relevant to this workplace, with structured materials and on-site equipment (huge tanks). The next session concentrated on the relationship between length, area and volume and how to calculate and record it, using similar equipment. The remaining sessions concentrated on problem-posing activities at the main depot, applying and developing skills with calculators and measurement to workplace tasks. A full practical session at another water treatment site, to check the accuracy of meters and set up a recording sheet, rounded off the program.

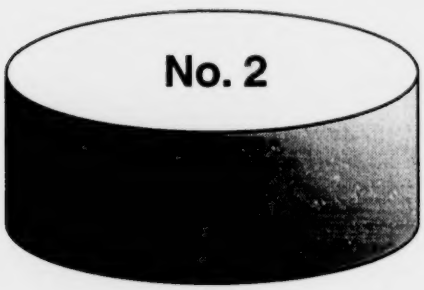
For a similar program to be successful, it is essential that the metric units and their relationship to each other be explored through the use of concrete materials. The participants in this course came back to the equipment and the basic concept regularly as they worked through the different activities.

Wagga Water Treatment Plant



Diameter = 18·1m

Diameter = 23·8m



Diameter = 19·32m

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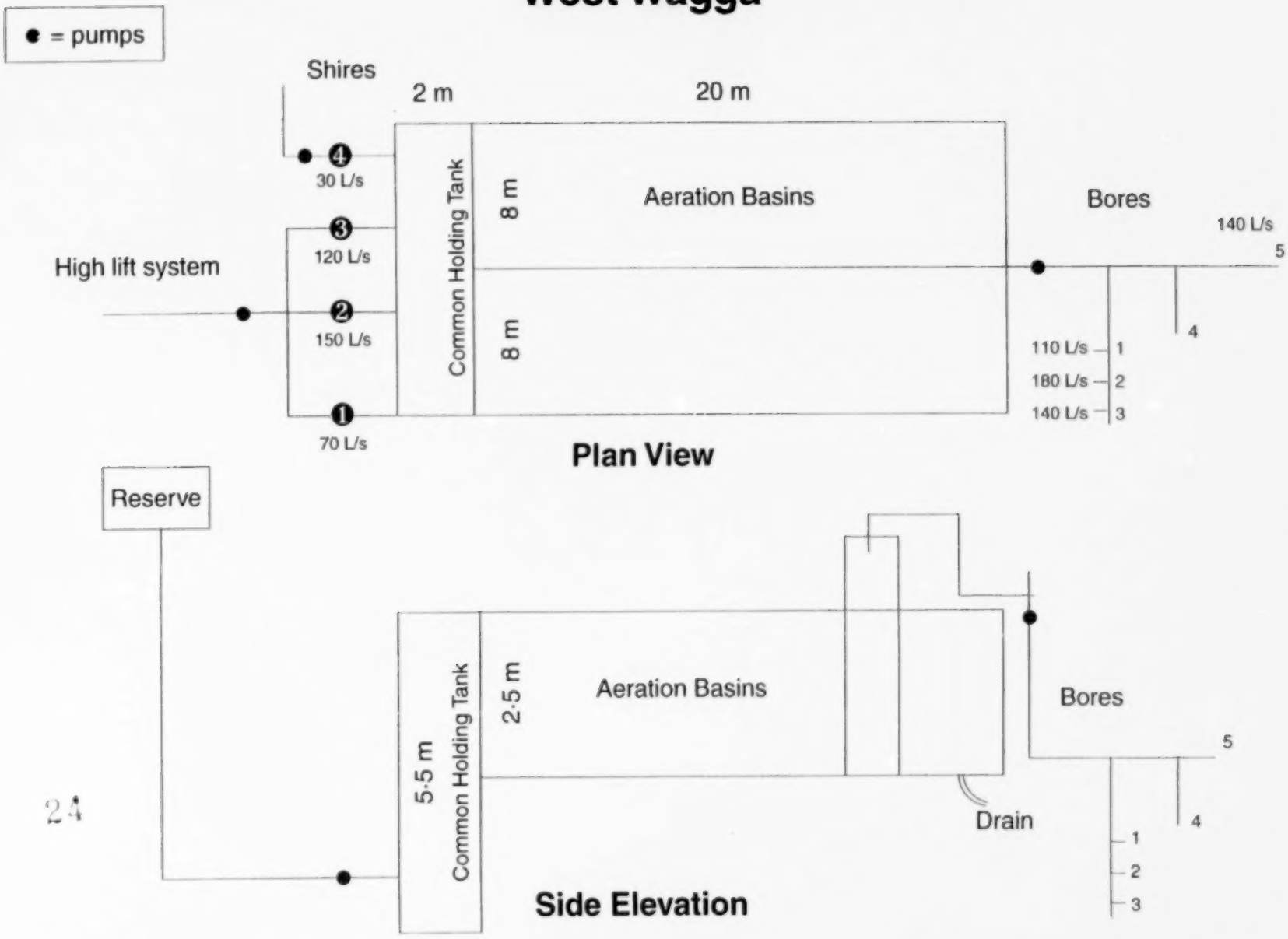
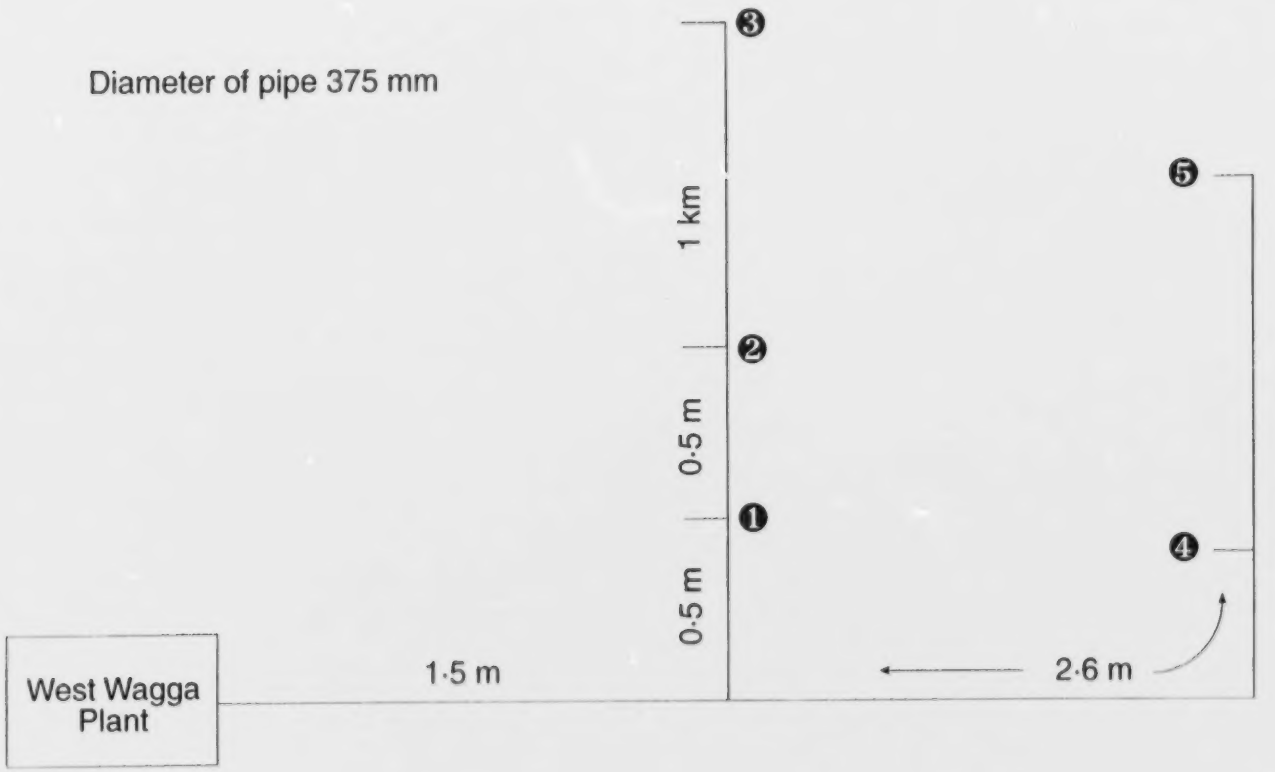
West Wagga


● = pumps
Shires
2 m
20 m
4
30 L/s
3
120 L/s
High lift system
2
150 L/s
1
70 L/s
Common Holding Tank
8 m
8 m
Aeration Basins
Bores
140 L/s
5
4
110 L/s — 1
180 L/s — 2
140 L/s — 3
Plan View
Reserve
5·5 m
Common Holding Tank
2·5 m
Aeration Basins
Bores
5
4
Drain
1
2
3
Side Elevation

West Wagga Bore System



SAMPLE WORKSHEET

Revision—capacity of tanks

The first activity presented here is revision because the initial activities at Wagga were practical learning sessions.

Note: The symbol L has been used for litres to avoid confusion with the numeral 1. This is one instance in which both metric symbols are accepted under S.I. (Système International d'Unités) guidelines.

Calculate the capacity of the following tanks:

Wagga Wagga

1. No. 1 settlement tank

   D = 19·32 m

   H = 6·12 m

   h = 2·35 m

   Capacity = _____

   _____

   _____

2. No. 2 settlement tank

   D = 23·8 m

   H = 6·12 m

   h = 2·35 m

   Capacity = _____

   _____

   _____

3. Clear water storage

D = 18·1 m

H = 6·12 m

Capacity = _____

_____

_____

West Wagga

4. Aeration basins (2)

Length = 20 m

Width = 8·28 m

Depth = 2·5 m

Capacity = _____

_____

_____

5. Common holding tank

Length = 17 m

Width = 2 m

Depth = 5·5 m

Capacity = _____

_____

_____

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6. Using the dimensions on the previous pages, calculate the capacity of each tank *per metre* of depth (not in cone areas).

No. 1 settlement tank

Capacity = _____

_____

No. 2 settlement tank

Capacity = _____

_____

Clear water storage

Capacity = _____

_____

Aeration basin (1)

Capacity = _____

_____

Common holding tank

Capacity = _____

_____

30

SAMPLE WORKSHEET

Meter accuracy

1. It takes 27 minutes to raise the level of the clear water storage tank by 1 metre, while pumping into plant no. 1. The meter records a combined flow of 180 litres/second.

   Are the pumps pumping more or less than the meter is recording?

2. It takes 21 minutes to raise the level of the clear water storage tank by 1 metre. The meter records a combined flow rate of 180 litres/second.

   Are the pumps pumping more or less than the meter is recording?

3. It takes 43 minutes to raise the level of the Clear Water Storage tank by 1 metre. The meter records a flow rate of 100 litres/second.

   Is the pump pumping more or less than the meter is recording?

4. It takes 45 minutes to raise the level of the clear water storage tank by 1 metre. The meter records a flow rate of 90 litres/second.

   Is the pump pumping more or less than the meter is recording?

5. It takes 62 minutes to raise the level of the clear water storage tank by 1 metre. The meter records a flow rate of 75 litres/second.

   Is the pump pumping more or less than the meter is recording?

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SAMPLE WORKSHEET

Percentage accuracy of meters

Using the examples in 1 to 5 on the previous page, calculate the percentage accuracy of each example.

$$\text{Percentage accuracy} = \frac{\text{volume metered} \times 100}{\text{capacity } (m^3)}$$

$$= \pm \quad \%$$

SAMPLE WORKSHEET

Capacity of pipes

How do you calculate the capacity of a pipe? Yes, find the area of the cross section of a pipe from the diameter of the pipe, then multiply by the length of the pipe.

Area = _____ or _____

= _____ m^2

Volume = area x length

= _____ m^3 1 kL = 1 _____

Calculate the capacity of the following:

150 m of 375 mm pipe.

1 km of 375 mm pipe.

3·5 km of 375 mm pipe.

5·8 km of 375 mm pipe.

600 m of 450 mm pipe.

25 m of 450 mm pipe.

27 km of 250 mm pipe.

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TYPICAL WORKPLACE TASKS

Wagga waterworks—meter accuracy

Problem: You want to check the accuracy of the meters on the two pumps into plant no. 1.

How will you go about it?

What information do you need?

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TYPICAL WORKPLACE TASKS

West Wagga system—capacity of pipes

Problem: As a group, you have just cleaned a bore some distance from the plant and there is going to be some dirty water to discard. You don't want to waste the clean water in the pipeline. You need to work out how to discard as little water as you can.

How will you go about it?

What information do you need?

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TYPICAL WORKPLACE TASKS

West Wagga—bore pumps and flow rates

How much water would be in the pipeline from bore no. 2 to the aeration basin?

How long would it take to pump that amount of water with a flow rate of 180 litres/second?

Complete the above for each of the bores (assume a flow rate of 120 litres/second for pump 4).

	Capacity of pipe	Time to pump
Bore 1		
Bore 2		
Bore 3		
Bore 4		
Bore 5		

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TYPICAL WORKPLACE TASKS

West Wagga—high lift pumps

What would be the maximum capacity per day for the shire's high lift pump?

How long would it take to empty the holding tank with no. 2 high lift pump operating?

On 4 January 1990 the output of two pumps was 23·75 megalitres/day. Is this possible? Which two pumps would this output be from, and for how many hours would they have run?

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Measurement for dogging skills

Delivery recommendations

The module Measurement for Work grew out of the awareness of the necessity for measurement in many areas of work in local government. This is especially so for stores and outdoor staff when they are preparing lifts and directing loads. To do this they must have a dogging skills licence or, prior to 1995, a crane chasers licence.

There are four dogging skills modules in the Certificate in Local Government Foundation Studies, and together they form the Dogging Skills Statement of Attainment. They are:

- Dogging Legislative Provisions
- Load Moving Preparation
- Job Planning and Programming
- Slinging and Gear Storage

It is recommended that Measurement for Work be taken either concurrently with or prior to the delivery of dogging skills training. Ideally, Measurement for Work would begin a few weeks before any dogging skills, with an overlap to link specific tasks.

The dogging skills modules are challenging, with high language, literacy and numeracy demands. Participants may need Tutorial Support as well as Measurement for Work to successfully complete them. Confidence with the numeracy demands will allow the students to concentrate on the content and language of the course.

Numeracy skills

The numeracy skills required are those outlined in Measurement for Work. Participants must be competent with a calculator and be able to calculate the mass of typical workplace loads. Therefore, knowledge of metric measurement, the sub-multiples of units of measurement, and how to calculate the volumes of regular shapes are key skills.

Safe working load (SWL) and diameter of slings

The setting up of loads involves calculating the minimum-sized sling required to comply with the SWL of different sling types. There are many different factors to consider when calculating the type and size of sling required. This is part of the content of the dogging skills modules. Teachers must cover the concepts of squaring numbers and square roots of numbers to prepare

participants for this aspect of dogging skills. However, if there is overlap or the modules are taught concurrently, close liaison with the dogging skills teacher, to identify how they are used, may allow consolidation of the dogging skills formulas as well.

Assessment

To prepare students for written assessment in dogging skills, a 'practice' formal assessment is suggested.

Tasks in the workplace

Workers may be required to calculate the mass of the following to prepare a load for lifting:

- lengths of pipe—both concrete and steel
- concrete culverts
- stacks of timber
- bins of scrap steel or building material
- concrete blocks
- pallets of pavers
- motors, equipment
- sheets of steel
- lengths of steel (beams and trusses)
- concrete tanks

Some loads which may be lifted in local government work, such as motors and containers, will display their mass. In these cases the slings required to meet SWL can be calculated directly.

For many loads, mass must first be calculated, using the formulas for the volume of cubes, rectangular prisms or cylinders and the table of mass per cubic metre.

Some common masses/cubic metre

steel	7.8 t/m^3
concrete	2·4 t/m^3
water	1 t/m^3
hardwood	1·1 t/m^3

A comprehensive list of masses is available in *A Guide for Dogging*, available from WorkCover Authority of NSW, Locked Bag 10, Clarence Street, Sydney 2000.

The calculation that creates most difficulty is the mass of a pipe. This calculation involves the subtraction of the volume of the inner diameter from the outer diameter, to obtain the volume of the shell of the pipe. Many participants remember the formula from school:

$$\text{volume of a cylinder} = \pi \times r^2 \times \text{length}$$

However, it may be less confusing to use the following formula, in which the size of the pipe is always expressed in diameter:

$$\text{volume of a cylinder} = \frac{\pi \times r^2}{4} \times \text{length}$$

Note: Participants do not always know that the vinculum is a divide sign.

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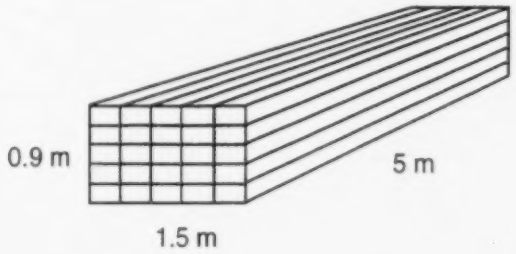
TYPICAL WORKPLACE TASKS

In the dogging skills modules, participants must be able to calculate the mass of the following types of examples.

Note: A common area of difficulty is converting millimetre measurements to metres when calculating area and volume.

1. Hardwood stack



Formula _____

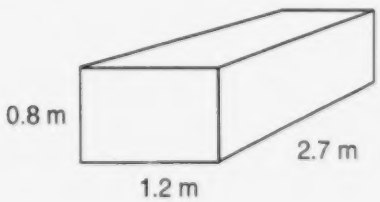
Volume = _____

_____

Mass = _____

_____

2. Concrete block



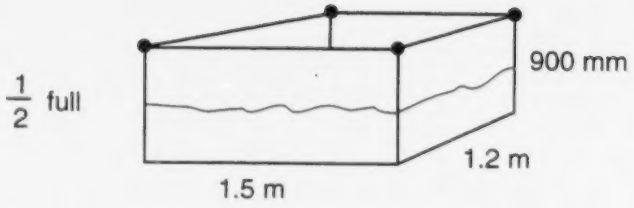
Formula _____

Volume = _____

_____

Mass = _____

3. Bin of scrap teel



Formula _____

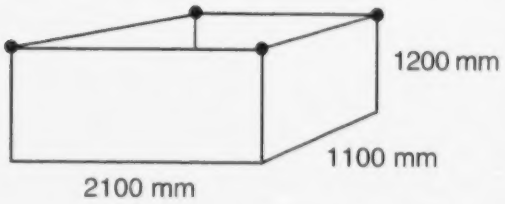
Volume = _____

_____

Mass = _____

_____

4. Bin of timber off-cuts



Formula _____

Volume = _____

_____

Mass = _____

42

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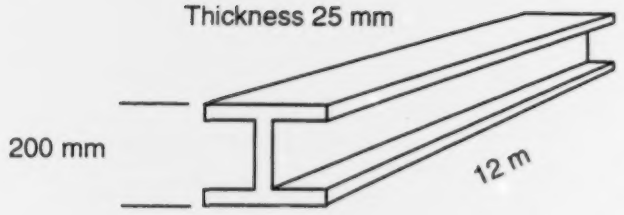
5. Length of steel



Formula _____

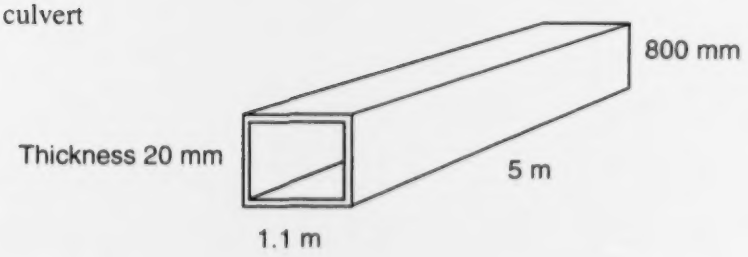
Volume = _____

_____

Mass = _____

_____

6. Concrete culvert



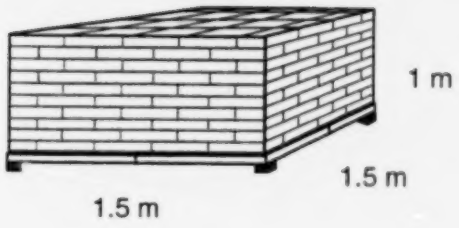
Formula _____

Volume = _____

_____

Mass = _____

7. Pallet of pavers



Formula _____

Volume = _____

_____

Mass = _____

_____

8. Sheet of steel

Formula _____

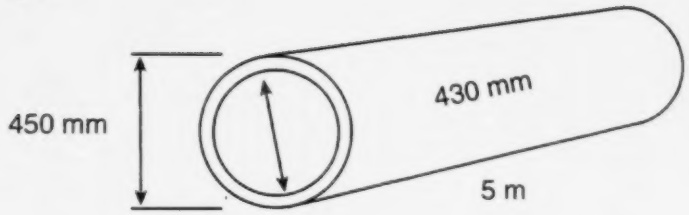
Volume = _____

_____

Mass = _____

Mass = _____

9. Concrete pipe



Volume of a cylinder _____

Volume 1 = _____
(of inner diameter)

_____

Volume 2 = _____
(of outer diameter)

_____

Volume 2 – volume 1 = _____

Actual volume = _____

Mass = _____

_____

Note: The volume of the larger diameter is calculated second to allow the answer to remain on the calculator ready for the subtraction of the volume of the smaller diameter. This is a minor consideration and you may wish to calculate in the reverse.

Examples of diameters of pipe:

375 mm 450 mm 900 mm 1200 mm 1800 mm

Thickness can vary from 10 mm to 50 mm and perhaps larger. Participants will be able to contribute examples of sizes which they encounter at work.

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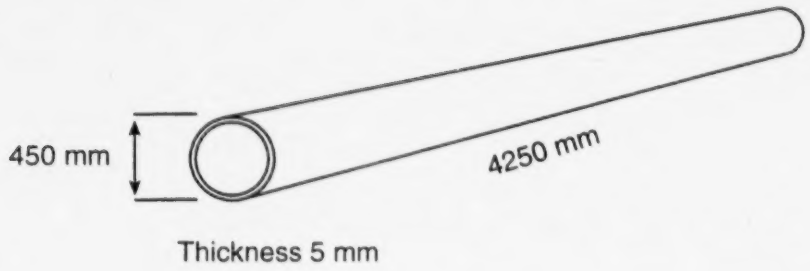
10. Steel pipe



Volume of a cylinder

Volume 1 = _____
(of inner diameter)

_____

Volume 2 = _____
(of outer diameter)

_____

Volume 2 – volume 1 = _____

Actual volume = _____

Mass = _____

_____

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Measurement for parks and gardens and horticulture

Workers in the parks and gardens and the horticulture areas of local government have many and varied tasks involving the use of measurement. Some activities which involve measurement include:

- lifting and slinging loads
- spreading fertiliser
- spraying insecticide, weed killers
- constructing playgrounds
- landscaping
- fencing
- tree planting
- laying paths and edging
- laying pavers
- top dressing lawns
- installing watering systems.

Mathematical tasks required by these workers may also include the costing of materials required for projects. This extends beyond the learning outcomes for this module, but depending on the group, may be a valid activity if time permits. These activities can be negotiated in order to contextualise the content of the module to the workplace and to meet the needs of the group.

There is a higher incidence of the use of perimeter in this area of local government than in the previous examples. Perimeter for square and rectangular shapes, when it is taught by formulas, can be confused with area. I have found that simply adding the distances around the outside to obtain perimeter can eliminate that confusion. For circles, unfortunately, there is no way of avoiding it that we know about.

There are myriad opportunities for practical introductory activities to develop measurement skills in this area. Whether the module is taught on-site, on-the-job or at a TAFE college there are examples of typical tasks nearby. Structured materials and measurement equipment can be used to introduce and/or extend concepts and skills with metric measurement.

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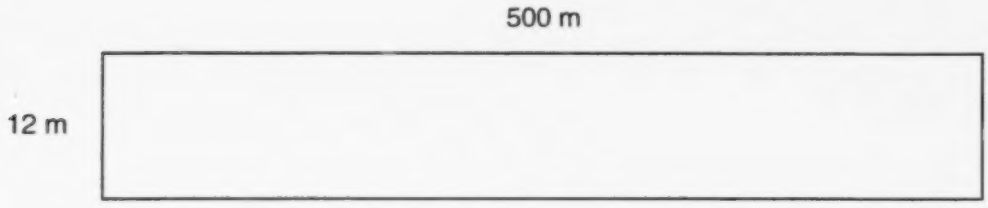
SAMPLE WORKSHEET

1. Fencing

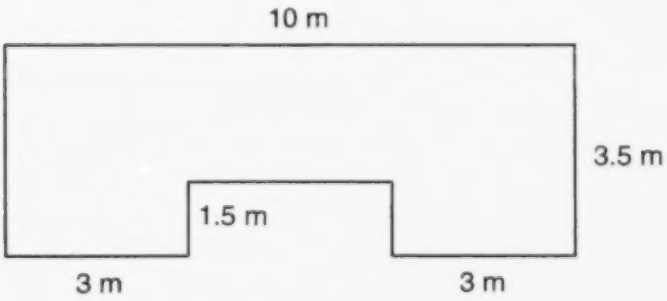
   a) How many metres of fencing will be needed to fence the following tree plantation:



   b) Three rows of trees are to be planted in the plantation. The trees are to be 3·5 metres apart. Draw up a plan of the trees to calculate the number required.

2. Paving

   a) The following area is to be paved with concrete pavers. How many square metres of pavers will be used?



   b) The pavers are to be laid in a bed of 100 millimetres of sand. How many cubic metres of sand will you need to spread over the area?

Note: A common area of difficulty is converting millimetre measurements to metres when calculating area and volume.

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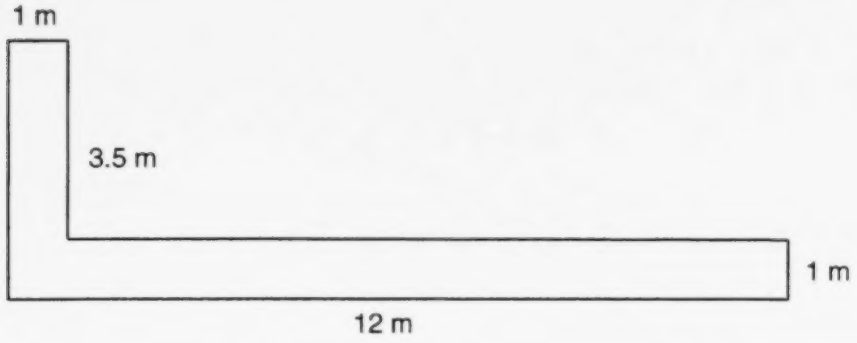
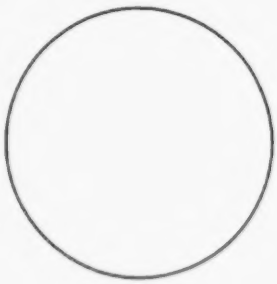
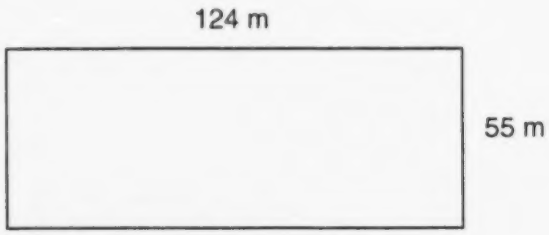
3. A concrete path.
   You are to lay a concrete path with these dimensions. How many cubic metres of concrete will you need?



4. A circular concrete base is being laid to support a water tank with a diameter of 2500 millimetres. The base is to be 20 millimetres deep. How much concrete will you need?



5. You are to top-dress the football field with an average cover of 10 millimetres. How much sandy loam will be used?



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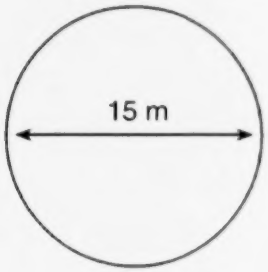
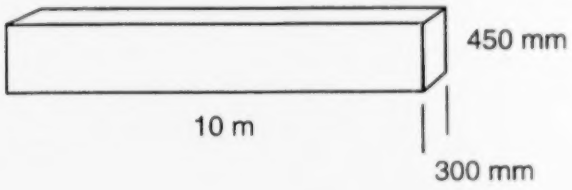
6. Fertiliser is to be spread at a rate of 20 grams per square metre. How many kilograms would you use to fertilise this circular lawn? (Actual labels of relevant fertilisers would be recommended.)



7. To spray street trees you need to mix up a 200-litre drum of chemical solution. The solution ratio is 5 millilitres to 5 litres of water. How many millilitres of chemical will you use? (Actual labels of relevant chemicals would be recommended.)

8. The scoop on the front-end loader holds approximately 0·5 of a cubic metre of soil, tan bark, and so on. If you are going to load the truck with enough soil to fill in this trench, how many scoops will you use?



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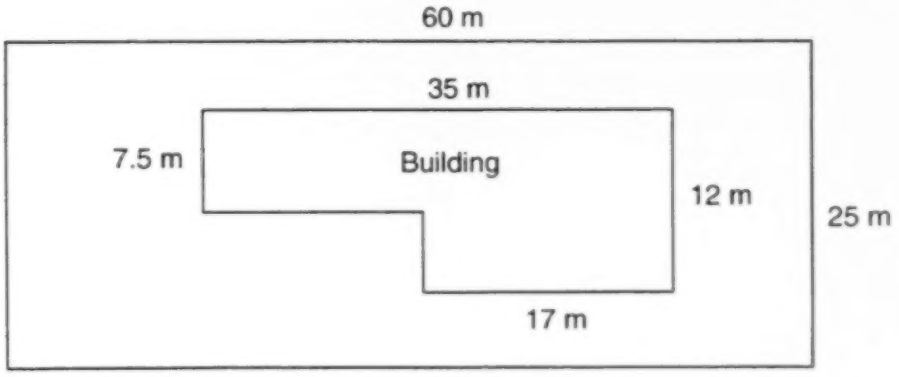
TYPICAL WORKPLACE TASK

Laying turf

After building works have been completed you are to lay turf in the following area:



You need to:

- spread soil to an average depth of 50 millimetres
- fertilise at a rate of 100 grams per square metre
- lay turf (ordered by the square metre).

What quantities of soil, fertiliser and turf will you use?

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TYPICAL WORKPLACE TASK

Landscaping

Your team is to establish a newly landscaped area of a suburban park which may incorporate:

- a paved area for seating
- a children's play area
- lawn
- an edged garden bed.

Either use an existing plan or draw up one in the group.

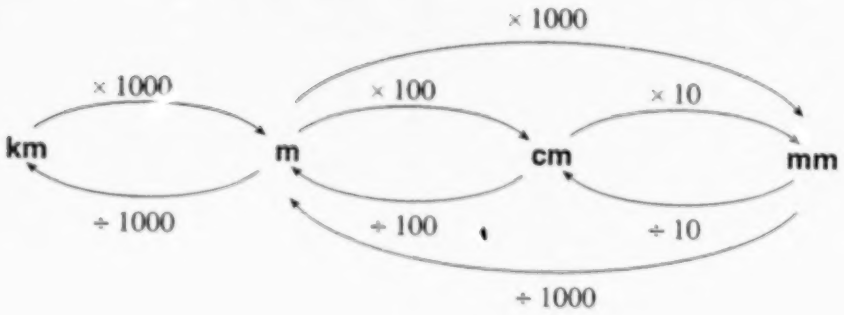
What do you need to know?

How will you calculate the quantities?

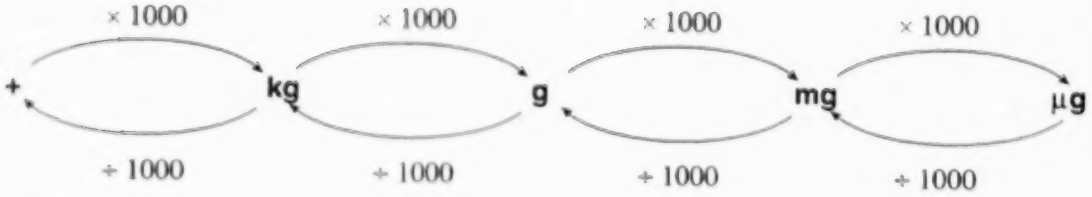
Appendix

Metric conversion factors

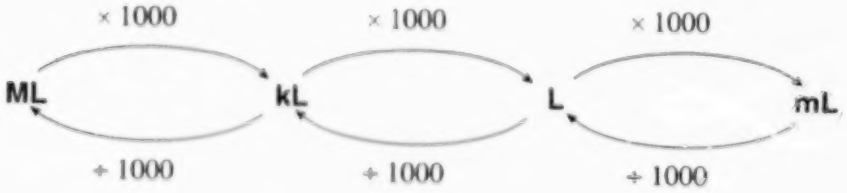
Length



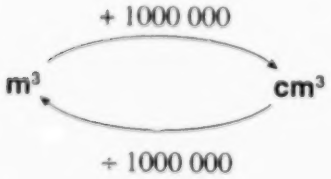
Mass



Fluid volume or capacity



Volume



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Metric prefixes

Prefix	Symbol	Relationship to base unit		
mega	M	10^6	or ×	1 000 000
kilo	k	10^3	or ×	1000
		Base unit		
milli	m	10^{-3}	or ÷	1000
micro	μ	10^{-6}	or ÷	1 000 000

Relationship between mass, capacity and volume

Capacity	Mass	Volume
1 litre (of water)	= 1 kilogram	= 1000 cubic centimetres
1 millilitre	= 1 gram	= 1 cubic centimetre
1 kilolitre	= 1 tonne	= 1 cubic metre

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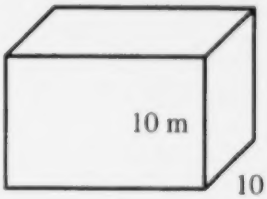
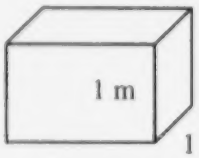
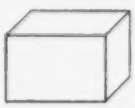
Capacity	Mass	Volume
1 ML (megalitre) 1 000 000 L (litres)	1000 t (tones) 1 000 000 kg (kilograms)	 10 m 1000 m^3
1 KL (kilolitre) 1000 L (litres)	1 t (tones) 1000 kg (kilograms)	
1 L (litre)	1 kg (kilogram) 1000 g (grams)	 1 000 000 mm^3
1 mL (millilitre) **(Not to scale)**	1 g = 1000 mg = 1 000 000 µg	1 000 mm^3

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Chemical dosing calculation chart

Chemical solution volume		Chemical solution strength		Chemical dry mass		Treated water flow rate		Chemical dosage (required)
→ mL/s	×	%	=	mg/s	÷	L/s	=	mg/L
	=	%	÷		=		×	←

Resources

See the list of recommended texts at the end of the module syllabus.

Also see Beth Marr and Sue Helme's 1991 publication *Breaking the Maths Barrier: A Kit for Building Staff Development Skills in Adult Numeracy* (Department of Employment, Education and Training, Canberra).

You may be interested in two numeracy resources which are being developed under the Wagga Wagga City and Regional Councils' WELL Project, and which should become available during 1996:

- *Self-Paced Units for Developing Calculator Skills*
- *Calculations Workbook*—developed to support calculations in the dogging skills modules of the local government certificates.

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